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Artificial Intelligence in Healthcare: Present Utilization, Key Challenges, and Emerging Opportunities

Sara Afzal[1*], Areeba Tariq[2], Zaryab Khan[3]

[1*]Faculty of Allied Health Sciences, Superior University, Lahore, Pakistan [2]Karachi Central Hospital, Karachi, Pakistan [3]Superior University, Sargodha, Pakistan

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CORRESPONDING AUTHOR

Sara Afzal
Superior University,
Lahore, Pakistan
drsaraafzal5@gmail.com

ABSTRACT

Background: Artificial Intelligence has rapidly emerged as a transformative force in healthcare, supporting advancements in clinical practice, diagnostics, treatment planning, and health system management. Its integration has improved accuracy, efficiency, and personalised patient care. However, alongside these advancements, significant challenges hinder its optimal utilization and widespread adoption. **Objective:** To explore the current utilization of artificial intelligence in healthcare, and identify key challenges associated with its development and implementation. **Methodology:** Relevant peer-reviewed articles, reports, and policy documents published between 2014 and 2024 were retrieved from PubMed, Scopus, Web of Science, and Google Scholar. Literature was screened for relevance and synthesised to provide an overview of current applications, challenges, and future opportunities. After the initial search, all records were screened for relevance based on titles and abstracts. Articles were included if they addressed applications of AI in healthcare, clinical decision support, medical imaging, treatment planning, telehealth, patient monitoring, ethical or regulatory considerations, or implementation challenges. **Results:** Artificial intelligence is currently utilized in diagnostic imaging, predictive analytics, clinical decision support, telemedicine, robotic surgery, drug discovery, and personalized medicine. These applications contribute to faster diagnosis, improved treatment outcomes, and enhanced healthcare efficiency. However, adoption remains limited due to challenges such as data privacy concerns, algorithmic bias, high implementation costs, lack of clinician training, and insufficient regulatory clarity. Emerging opportunities include explainable artificial intelligence, enhanced data governance, interdisciplinary collaboration, and increased access to AI-driven tools through scalable digital health solutions. **Conclusion:** Artificial intelligence holds substantial potential to advance healthcare delivery. Addressing existing challenges through ethical practices, strengthened regulations, capacity building, and equitable access will be essential for harnessing AI's emerging opportunities to improve global health outcomes.

Keywords: Artificial intelligence, Clinical applications, Ethical and future directions, Healthcare technology, Regulatory frameworks

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INTRODUCTION

Artificial Intelligence (AI) is now one of the most important technologies in healthcare. AI means computer systems that can learn from data, see patterns, and make decisions that used to need human thinking. In the last few years, there has been a rapid growth in tools and studies about AI for hospitals and clinics.[1,2] This growth was made possible by improvements in machine learning methods, larger digital health datasets, and stronger computing power.[3] Due to these changes, AI is no longer only a future idea; many health services are trying to use it now. Health systems face growing problems: more patients, higher costs, and not enough trained staff. These problems make it necessary to find tools that help with early diagnosis, work more efficiently, and support personalised care. AI can look at very large amounts of data, find patterns that humans may miss, and do routine tasks automatically.[3] Clinical decision support that uses AI can give doctors extra information to reach better and faster decisions, which may reduce mistakes and variation in care.[8]

One of the clearest uses of AI is in medical imaging. AI algorithms are being applied to X-rays, CT scans, MRI scans, and mammograms to help spot disease and prioritise urgent cases.[4] A high-profile 2017-2019 line of work showed that deep learning can match expert doctors for certain image tasks, and later studies proved similar performance for breast cancer screening and lung nodule detection.[5,6] Radiology is now a major area where AI assists clinicians by improving detection, shortening report time, and supporting earlier treatment.[7] It is also helpful for planning treatment and for personalised medicine. Machine learning models can combine clinical, genetic, and lifestyle data to predict how a disease may change and how a patient might respond to treatment.[2,3] This is important in cancer care, where AI helps to find biomarkers, suggest therapies, and estimate outcomes for patients.[9]

In drug discovery, AI speeds the search for promising compounds and supports smarter clinical trial plans, which could reduce time and cost for new medicines. AI supports new ways of delivering care as well. Telemedicine services with AI features let doctors do remote consultations, help in triage, and monitor patients over time.[10] The COVID-19 pandemic pushed the rapid use of virtual care and showed how AI can support disease monitoring and planning. Wearable devices that use AI can track vital signs and give early warnings for health problems, helping people manage chronic conditions outside the hospital.[11] These technologies may reduce pressure on hospitals and improve access for people in remote or low-resource places. However, there are important challenges before AI can be used widely. Patient data privacy and security are major concerns because health data are sensitive and must be protected.[12] Ethical issues, such as transparency and responsibility, arise when AI acts like a "black box" and users cannot see how decisions are made. Algorithmic bias is another major problem: if training data do not represent diverse populations, AI may give worse results for some groups and deepen health inequalities.[13]

Health workers also need training and confidence to use AI tools. Many medical and nursing programmes give little formal education on AI, which causes worry and slow adoption.[14] Other barriers include costs for implementation, weak technical infrastructure in some hospitals, and changes to clinical workflow that come with new digital systems.[15] Addressing these issues requires cooperation among clinicians, engineers, health managers, and policy makers so systems are safe and useful. In recent years, there has been more attention to explainable AI, fairness, and clear regulation to make AI safer for patients and clinicians. Governments and health agencies are working to build regulatory frameworks and ethical guidance for AI in health.[13] If these challenges are handled well, AI could support earlier diagnosis, more patient-centred care, and better health outcomes across many settings. This review describes the current uses of AI in healthcare, highlights the main challenges that limit adoption, and discusses emerging opportunities that could shape how AI helps health systems in the near future.

METHODOLOGY

This review was designed to provide a comprehensive overview of how AI is currently being used in healthcare, the challenges affecting its adoption, and the opportunities for its future development. A narrative review approach was chosen to allow a broad and descriptive synthesis of the available literature, rather than focusing on a narrowly defined research question. This method is suitable for exploring a rapidly evolving topic such as AI in healthcare, where the goal is to summarise key findings, identify trends, and

provide insight into emerging opportunities and barriers.

To identify relevant literature, major electronic databases were searched, including PubMed, Scopus, Web of Science, and IEEE Xplore. The search was conducted for publications between 2015 and 2025 to capture the most recent and relevant advances in AI technology and its applications in healthcare settings. Keywords and combinations of terms were used to ensure comprehensive coverage. These included "Artificial Intelligence", "machine learning", "deep learning", "healthcare", "clinical decision support", "medical imaging", "telemedicine", "digital health", "personalised medicine", "AI ethics", and "AI regulation". Boolean operators such as AND, OR, and NOT were used to refine the search strategy. Additional relevant studies were identified by screening the reference lists of key articles and reviews, a method that helped to include influential publications that might not appear in the primary database search.

After the initial search, all records were screened for relevance based on titles and abstracts. Articles were included if they addressed applications of AI in healthcare, clinical decision support, medical imaging, treatment planning, telehealth, patient monitoring, ethical or regulatory considerations, or implementation challenges. Studies that did not focus on healthcare contexts, such as purely technical AI algorithm papers without clinical application, were excluded. Only articles published in English were considered to ensure consistency in interpretation. Both original research and review articles were included to provide a broad perspective on the current state of AI in healthcare. Preference was given to peer-reviewed studies and publications from recognised institutions to ensure reliability and credibility.

The full texts of selected articles were reviewed carefully to extract relevant information. Data were organised thematically into major domains, including clinical applications, medical imaging, personalised medicine, telemedicine and remote monitoring, implementation challenges, ethical issues, and regulatory frameworks. Within each domain, key findings, notable examples, and evidence-based outcomes were summarised. This approach allowed for a structured presentation of information while preserving the narrative flow, which is a defining feature of narrative reviews. Examples of AI tools and their applications were highlighted to provide practical context and demonstrate real-world use in healthcare systems. Quality assessment was carried out informally, considering the credibility of journals, authors, and institutions, as well as the methodological soundness described in each study. While formal systematic quality scoring was not applied, studies were evaluated based on relevance, clarity of methods, and the robustness of results. The findings were then synthesised narratively, identifying patterns, common challenges, and opportunities across different healthcare settings. Trends and emerging developments were emphasised, along with insights from recent technological advancements, policy developments, and clinical implementation experiences.

By adopting this approach, the review offers a comprehensive overview of the field, highlighting the current utilisation of AI, barriers to effective integration, and potential directions for future development. The narrative synthesis allows readers to understand the broad implications of AI in healthcare, appreciate its potential benefits, and recognise the challenges that must be addressed for its successful and ethical implementation. This methodology ensures a structured, transparent, and informative review of contemporary literature on AI in healthcare, supporting evidence-based insights and recommendations for clinicians, policymakers, and researchers interested in AI technologies.

DISCUSSION

The analysis of the reviewed literature revealed several key areas where AI has been applied in healthcare, along with notable outcomes, challenges, and emerging opportunities. Across all studies, AI was found to significantly influence clinical decision-making, medical imaging, treatment planning, telemedicine, and patient monitoring, while also presenting challenges related to ethics, implementation, and regulation.

One of the most consistent findings was the widespread use of AI in medical imaging. Deep learning and machine learning algorithms were reported to improve diagnostic accuracy for a variety of imaging modalities, including X-rays, computed tomography (CT), magnetic resonance imaging (MRI), and mammography.[16] Studies demonstrated that AI systems could detect abnormalities such as lung nodules, breast lesions, and brain tumors with accuracy comparable to,

and in some cases exceeding, that of experienced radiologists.[17] In addition to detection, AI-assisted imaging platforms were shown to reduce reporting time and assist radiologists in prioritising urgent cases, which improved workflow efficiency.[18]

Some studies highlighted the potential for AI to reduce human error, standardise interpretations, and support early diagnosis, which is especially important for time-sensitive conditions such as stroke and cancer.[19] AI's role in clinical decision support and personalised medicine was also prominent. Machine learning models that integrate clinical, genetic, and lifestyle data were used to predict disease progression and treatment responses.[20,21] Evidence indicated that these models could support physicians in selecting optimal treatment plans, particularly in oncology, by identifying suitable therapies based on patient-specific biomarkers.[22] Several studies noted that AI could improve risk stratification, facilitate individualized care, and enhance patient outcomes.[23] In addition, AI-assisted drug discovery was increasingly cited as a promising application, with algorithms capable of identifying potential compounds, predicting pharmacokinetics, and optimising clinical trial design, ultimately reducing the cost and duration of drug development.[24]

Telemedicine and remote patient monitoring emerged as another key area of AI application. Studies showed that AI-powered telehealth platforms improved access to healthcare services, particularly during the COVID-19 pandemic.[25] AI systems supported triage, automated symptom assessment, and continuous monitoring of vital signs using wearable devices.[26] The literature suggested that such technologies could enhance care for chronic disease patients, reduce hospital visits, and expand services to remote or underserved populations. These findings indicate that AI-enabled digital health tools can contribute to both efficiency and patient-centred care.[27]

Despite these benefits, several challenges were consistently reported across studies. Data privacy and security remained a major concern due to the sensitive nature of health information. Ethical issues, including algorithmic transparency, explainability, and accountability, were frequently highlighted. Black-box AI models created uncertainty among clinicians, reducing trust and adoption rates. Algorithmic bias was also reported, especially in models trained on datasets that were not representative of diverse populations, which risked reinforcing health disparities. Training gaps among healthcare professionals were noted as a barrier, as clinicians often lacked formal education or digital literacy to use AI effectively. Implementation challenges extended to infrastructure and workflow integration. High costs of AI systems, lack of technical support, and disruption to clinical routines were reported as barriers to adoption. Studies suggested that collaborative planning involving clinicians, engineers, and policymakers is crucial to overcoming these hurdles.

Regulatory and ethical frameworks for AI use in healthcare were still evolving. Governments and health agencies were actively developing guidance to ensure safe, responsible, and ethical application, but gaps in standardisation and enforcement were noted.[28] The literature also highlighted emerging opportunities for AI. Explainable AI (XAI) and interpretable machine learning were gaining attention as methods to improve transparency and trust in clinical decision-making.[27] AI applications were being expanded to population health management, predictive analytics for hospital resource planning, and early disease outbreak detection.[25] Several studies underscored the potential of AI to complement, rather than replace, clinicians, enabling better decision-making, improved efficiency, and enhanced patient outcomes when integrated thoughtfully into healthcare systems.[24]

The findings indicate that AI has already made significant contributions to healthcare, particularly in imaging, clinical decision support, personalised medicine, telemedicine, and drug development. At the same time, adoption is limited by ethical, technical, and educational barriers. Addressing these challenges through training, regulatory guidance, transparent AI systems, and interdisciplinary collaboration will be essential to fully realise the potential of AI. Collectively, the evidence suggests that AI has a transformative role in healthcare, with the capacity to improve diagnosis, treatment, and patient care while shaping the future of health systems globally.

CONCLUSION

Artificial Intelligence is becoming an important part of modern healthcare, improving diagnosis, clinical decisions, personalised treatment, and remote patient care. Evidence from the reviewed literature shows that AI has brought clear benefits

in medical imaging, oncology, drug development, and digital health. In imaging, AI systems can detect abnormalities with accuracy close to expert clinicians while reducing workload and helping with early diagnosis. In personalised medicine, AI helps select suitable treatments based on individual patient data, improving care quality. Telemedicine and AI-based wearable devices also support continuous monitoring, increase access to care, and reduce pressure on hospitals, especially in low-resource settings.

However, several challenges limit the widespread adoption of AI. Ethical issues such as transparency, accountability, and algorithmic bias must be addressed to keep healthcare fair and safe. Protecting patient data privacy is essential, as health records are highly sensitive. High costs, limited digital skills among health workers, and poor technical infrastructure also slow implementation. Regulatory guidance is still developing, and more effort is required to make AI systems reliable, explainable, and trustworthy. Overall, AI has strong potential to transform healthcare. With proper policies, training, and collaboration among key stakeholders, AI can support safer, more efficient, and patient-centred healthcare in the future..

DECLARATIONS

Consent to participate: Written consent had been obtained from patients. All methods were performed following the relevant guidelines and regulations.

Availability of Data and Materials: Data will be made available upon request. The corresponding author will submit all dataset files.

Competing interests: None

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